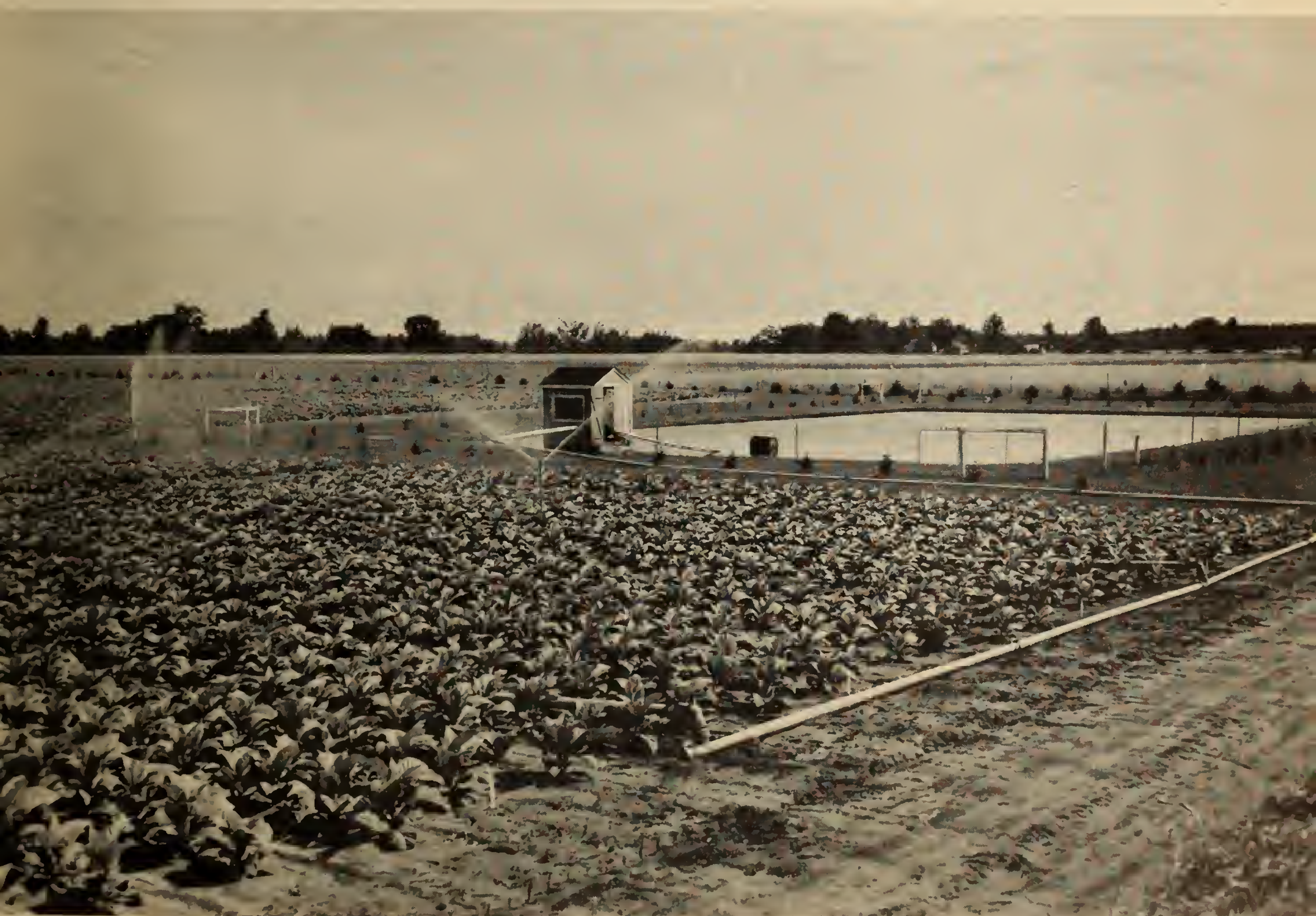
Research FOR FARMERS

SPRING — 1959



CANADA DEPARTMENT OF AGRICULTURE

Research FOR FARMERS

CANADA DEPARTMENT OF AGRICULTURE
Ottawa, Ontario

HON. DOUGLAS S. HARKNESS, *Minister* — J. G. TAGGART, C.B.E., *Deputy Minister*

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Cover Photo — Sprinkler irrigating flue-cured tobacco from storage pond lined with vinyl plastic, Experimental Substation, Delhi, Ont.

NOTES AND COMMENTS

Few farmers nowadays would question the value of preventive measures against late blight of potatoes but the actual dollars and cents returns from a control program are really impressive. Tests at Charlottetown during the past ten years, involving a mean number of 6.7 applications of bordeaux mixture, produced 87.7 bushels per acre more than unsprayed fields. After removal of culls and rotted tubers, the advantage in favor of the sprayed areas was 125.5 bushels per acre. Cost of the chemicals used worked out to $14.87 per acre. Valuing the potatoes at one dollar per bushel, the increased value of the crop as a result of spraying would not only pay all materials and labor costs but would leave a tidy profit.

* * *

Experiments in Canada and elsewhere have shown that wheat can be grown on the same land year after year practically indefinitely. One of the results of this continuous cropping is the build-up of weed population, and a calculation made at Lethbridge Experimental Farm gives some indication of the problem. Counts made in a field where wheat had been grown continuously for 46 years, showed 2772 wild oat seeds per square yard of soil sampled to a depth of 3½ inches—something more than two seeds per square inch, stiff competition for grain.

* * *

Chemicals have long been prominent in the farmer's arsenal of weapons to combat the attacks of insect enemies. While it will probably be a long time before chemical insecticides disappear from the scene, there is promise in a new development involving the use of bacterial organisms to kill off noxious insects. Drs. Angus and Heimpel of the Insect Pathology Laboratory at Sault Ste Marie, whose article appears in this issue have been doing some work along this line. Elsewhere, commercial adaptation of the idea has already begun on a limited scale. While not all insects are susceptible to bacterial attack, a number of important agricultural pests can be controlled by this method.

* * *

Where moisture supplies are limited as in the prairie area, hay yields from grasses and legumes usually vary inversely with the plant population density. Tests conducted at Swift Current have shown that hay plants will yield more over a longer period of time when seeded in rows 12 or 18 inches apart, than with closer spacing. With rows sown six inches apart, yields were good for the first year but dropped off sharply in subsequent years. Yields from fields seeded at 12-inch spacing held up well for four years before beginning to decline. With 18-inch spacing of the rows, yield was a little low the first year but improved and remained high for six to eight years.

Sprinkler irrigation system in flue-cured tobacco plots at Delhi Substation.

Sprinkler Irrigation of Flue-Cured Tobacco

E. K. Walker

SPRINKLER IRRIGATION has become an important factor in flue-cured tobacco production within the last few years. The irrigated crop acreage has increased from less than 10 per cent to an estimated 70 per cent in 1958. Widespread interest in irrigation led to the initiation of a research program at the Tobacco Substation, Delhi, Ont., in 1953. Investigations were designed to supply information concerning the proper use of irrigation and the effects of irrigation on the quality, yield, and physical and chemical characteristics of flue-cured tobacco.

From 1953 to 1956, we found that the average increase in quality, yield, and gross return for irrigated tobacco over unirrigated was 5.5 cents per pound, 248 pounds per acre, and 234 dollars per acre, respectively. Irrigation also hastened crop maturity; the decrease in days to maturity was in direct proportion to the amount of applied water. Early maturity may be of decided benefit in some years in preventing loss from late summer frosts. Irrigation costs in a dry year, including both fixed and operating costs, have been estimated at 40 to 50 dollars per acre, so it is apparent that supplemental irrigation of flue-cured tobacco can be profitable.

Irrigation affects both leaf type and leaf quality. *Leaf type* is related to stalk position in that lug, cutter, body, and tip leaves occupy successively higher positions on the plant. *Leaf quality* is a reflection of the grade, and hence of the commercial value of the leaf. Color and luster are the most important factors in quality, but aroma, texture, stalk position, and thickness also have a bearing on the grade designation. These factors are interdependent, a variation in one factor being generally accompanied by changes in the others. The highest quality leaves are generally medium-sized, from intermediate stalk positions, and lemon to lemon-orange in color. They have a glossy sheen or luster, a smooth, silky, pliable, elastic, fine-grained texture, and are of medium thickness. However, more consideration is given to color than to any other factor, principally because it is relatively easier to separate leaves on the basis of color.

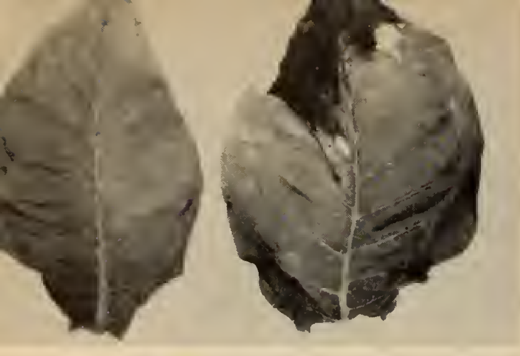
The author is a Tobacco Specialist at the Experimental Substation, Delhi, Ont.

Author conducting chemical analyses of leaf tissue.

Irrigation decreases leaf thickness, resulting in a relatively high proportion of desirable cutter and body leaves and a low proportion of less desirable tip leaves. Fortunately there is no apparent tendency for a shift from cutter to lug type of leaf. Although there is a similar proportion of lugs for both irrigated and unirrigated tobacco, the quality of the former is usually higher. Lugs are very sensitive to drought with the result that wilting, rim fire, necrosis, and even complete desiccation may cause a pronounced reduction of quality. These aberrations are sometimes prevalent on cutter but rarely on body or tip leaves. A moderate shift from body to cutter type may be desirable, but an extensive shift, such as may occur with excessive irrigation should be avoided.

Optimum irrigation tends to improve leaf color. The decrease of leaf thickness appears to be one of the most important factors involved in this improvement and may be the direct result of an increase in the size of irrigated as compared with unirrigated leaves. Prevention of drought damage is another reason for color improvement with irrigation.

Heavily irrigated tobacco, on the other hand, is characteristically lemon or pale yellow in color and has a washed-out appearance as compared with unirrigated tobacco or tobacco irrigated with smaller amounts of water. Such tobacco often has a papery, harsh, brittle



Damage caused by permanent wilting; undamaged leaf on the left.

or coarse-grained texture, and neutral aroma, and invariably lacks sheen or luster.

Improved color may be accompanied by a decrease in aroma and luster. Certainly, the oils, resins, and waxes in the leaves, which are believed to be responsible for the aroma and luster, are adversely affected by excessive applications of irrigation water.

Bright leaf color is associated with relatively low leaf contents of nitrogen and total alkaloids, and relatively high contents of sugars. As would be expected, nitrogen and total alkaloids are lower and sugars higher in irrigated than in unirrigated tobacco. The differences with respect to nitrogen and total alkaloids may be a matter of dilution, that is the utilization of less plant nutrients per unit of leaf weight by irrigated tobacco. An increase of leaf sugars with irrigation is considered to be caused by a reduction of nitrogenous constituents.

Dilution of nutrients or actual plant starvation may be responsible for the earlier maturity of irrigated tobacco. This could be the result of increased plant growth and complete usage of available plant nutrients. Although incomplete use of plant nutrients by unirrigated tobacco may explain a delay in maturity, differences were minimized by harvesting each plot when it was ripe. Differences in chemical composition were therefore considered to be the result of treatment rather than differences in maturity.

The *amount of irrigation water* should be in accordance with the rooting depth of the crop and the moisture-holding capacity of the soil to that depth. This is particularly important with sandy soils, which have a rapid rate of infiltration and a low moisture-holding capacity. Water applications in excess of the soil capacity for retention result in leaching of fertilizer and possible reductions of yield, whereas insufficient water may not only fail to satisfy the moisture requirements of the plants but necessitate irrigation at too frequent intervals. The moisture-holding capacity for the top foot of most flue-cured tobacco soils ranges from 1.0 to 1.5 inches.

Rate of water application is of minor importance in most flue-cured tobacco soils as they have infiltration rates equal to or higher than conventional application rates. Rates above 0.9 and below 0.3 inches per hour should be avoided because of the difficulty of

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Amount of Water Required to Raise Tobacco Soils from 25 Per Cent* Available Moisture to Field Capacity or 100 Per Cent

—	Depth of soil that must be saturated to affect the main root concentration (inches)	Amount of water required (inches)
First month in the field	6	0.38 to 0.59
First part of July	9	0.57 to 0.88
Middle of July	12	0.76 to 1.17
End of July	15	0.45 to 1.46
First part of August	20	1.27 to 1.95

*Actual irrigation water applications are only 75 per cent of the moisture-holding capacity, as irrigation commences before the soil moisture is reduced to the permanent wilting point.

Left: **Check plants on July 30. Note the relatively small size compared with irrigated plants, and wilting of lower plant leaves.** ***Center:*** **Plants irrigated according to Thornthwaite evapotranspiration estimates. These plants received 2.7 inches of water up to July 30.** ***Right:*** **Plants irrigated on a weekly basis whereby less than 1.0 inch per week of rainfall was made up to 1.0 inch with irrigation. These plants received 4 inches of irrigation water up to July 30. Note that the weekly treatment has caused a reduction in plant size from that obtained with the Thornthwaite method.**

Chickens on test in the brooder house, Central Poultry Testing Station, Ottawa.

Laying house at the Central Poultry Testing Station, Ottawa.

Egg Production Tests

Ottawa Tests Show Interesting Results

Mervin S. Mitchell

THE Central Poultry Testing Station at Ottawa, under the direction of the Poultry Division of Production and Marketing Branch with a Continuing Committee of poultry breeders active in an advisory capacity, was started in 1955. Since then three egg production tests and five broiler tests have been completed and the fourth egg production test is now under way.

The purpose is to provide facilities for testing the stock that poultry breeders offer for sale, directly or through hatcheries, to commercial poultry producers. Since all entries are tested under common environmental and management conditions, the results furnish a reliable indication of the economic qualities and performance of a breeder's stock. This is of value both to the breeders themselves in the development of their breeding programs, and to the poultry industry at large in assessing the merits of the various lines of commercial chicks available to the public.

The tests are referred to as 'random sample' tests, since the stock tested is selected at random from a breeder's flock. Tests of this nature were first undertaken in California ten years ago. They are now conducted in several states of the United States, in Britain, and Australia. In Canada, provincial tests are conducted in British Columbia and Alberta in addition to the Central Test at Ottawa.

The facilities at Ottawa consist of a brooder house equipped with incubators, and a laying house.

To start a test, departmental officers select a case of hatching eggs at random from each breeder's flock. These are sent to Ottawa where the chicks are hatched and sexed, and 120 pullet chicks selected at random to constitute the entry. All the chicks of all the entries are brooded together for the first eight weeks; they are then separated and each entry is divided into two pens of 60 birds each, located in different sections of the house. At 150 days of age the entries are transferred to the laying house, again in replicate pens.

The entries in the four egg production tests portray the trend in Canadian poultry breeding in the last few years. In the first test, in 1955, 76 per cent of the entries were of pure line breeding; the remainder were breed crosses. In the second test, 1956, most entries (69 per cent) were pure lines as in the first test. These stocks were the breeders' established strains that were being sold by them as breeding stock as well as commercial stock. By 1957, many breeders had begun to test strain and breed crosses and some already had crosses available in commercial quantities that could be sampled for an entry in the test. Thus in the third test 53 per cent of the entries were crosses —either crosses between different breeds or crosses between strains of the same breed. In the fourth test, started in 1958, almost all (94 per cent) of the entries are crossbreds. This means that most Canadian breeders now have organized their breeding programs into the production of crossbreds.

The superiority of crosses as commercial chicks is illustrated in the results of the third test completed in late August 1958. Of the 32 stocks on test, the top 13 were crosses. These thirteen included the only three White Leghorn strain crosses entered, and the remaining ten were either 'heavy' breed crosses, or 'light-heavy' crosses. Of the other six White Leghorn entries (all pure lines) and the nine pure-line heavies, the best record was 14th position. In the last ten positions, there were seven of pure-line breeding.

This is not to say that Canadian pure-line stocks are poor quality poultry. Rather, it is evidence that when Canadian pure lines are used to produce crosses, some extremely valuable commercial chicks are being produced. In the third test, the three pens ranking

—	Poorest performance	Best performance	Difference
Egg production	153	233	80 eggs
Egg size, percentage A Large or better	39.3	82.2	42.9*
Percentage mortality	26.5	0.0	26.5*
Lb. of feed per doz. eggs	6.0	4.0	2.0 lb.
Net revenue	$1.06	$3.00	$1.94

*Percentage points.

The author is a Geneticist, with the Poultry Division, Production and Marketing Branch, Ottawa.

highest in economy of production are of Canadian breeding.

Most random sample tests—and the Central Test is no exception—have a control stock on test along with all other entries. The control stock used in the Central Test is a random bred White Leghorn line developed at the Central Experimental Farm, Ottawa. This line was developed entirely through random selection of birds and the random mating of these birds. Theoretically this method produces a strain of chickens that remains genetically the same generation after generation. By having a similar genetic makeup in each generation the stock will, theoretically, perform the same each year —all factors of management being uniform between years. Thus the improvement in performance of any entry can be judged by comparison with the control-line performance.

Wide variations exist between entries in the tests. The figures given below are from data for the third test, and are the average of the two replicates.

In the accompanying table egg production, percentage mortality, and net revenue are calculated on a per-chick-started basis. The calculations are made in this manner to emphasize to poultrymen the importance of determining profits on each chick purchased rather than each hen housed. The net revenue is total receipts for eggs plus the meat value of the hens, less feed costs, chick costs and additional charges including such items as litter and vaccines.

The records obtained from random sample tests are used extensively by breeders for advertising purposes. Unfortunately many breeders over-emphasize some of their better records. To prevent this, the Continuing Committee has recommended that no records can be used for advertising purposes unless a complete record of the stock's performance is described. The Continuing Committee agreed that a complete record should include at least the record on (1) egg production per chick started, (2) percentage mortality, 7 days to 500 days, (3) percentage large-size eggs, and (4) lb. of feed per dozen eggs. They recommend that should a breeder use any portion of a Central Test record in advertising, he must at the same time show the ranking of his stock in net return per chick started for that test.

As the tests continue, two, three, and more years' records become available on a breeder's commercial chicks. This information, in conjunction with other records accumulated by the breeder on his own farm, as well as records obtained in the provincial random sample tests now conducted by the Alberta and British Columbia Departments of Agriculture, will give an excellent evaluation of commercial chicks available in Canada. To those who wish them, these records are available from the Poultry Division, Production and Marketing Branch, Canada Department of Agriculture, Ottawa.

FIELD PEAS

Require Careful Management

F. Gfeller

In Canada, field peas are used chiefly for the soup trade. They differ from the canning peas as to variety grown and the stage and method of harvesting the crop. However, the quality requirements for both types are very exacting with respect to color, uniformity of size, and flavor. Varieties of peas preferred for canning are the green wrinkled types, whereas varieties used for the soup trade are the yellow, round, and smooth types. The number of varieties bought for the canning or soup trades is restricted and this enables the industries to control the quality of their products more effectively.

The field peas commonly grown in Canada are: Chancellor, Arthur, Stirling, and Valley. There is a small demand (5 to 10 per cent of market demand) for blue-seeded, smooth peas. This has been supplied in the past by the production of Idabell, and more recently by B.C. Blue, a derivative from the variety Blue Bell.

The commercial varieties in production at present have been grown for the past 20 to 50 years. These varieties have maintained yields during this period, and the yields compare favorably with those obtained in England, Australia, and the United States. Fortunately most of the diseases that are common on field peas at present are not usually severe enough to cause a total crop loss.

We in the Cereal Crops Division are responsible for maintaining pure seed stock of all varieties at present used in commerce. These seed stocks cannot contain more than 2 per cent of seeds infected with Ascochyta diseases, which causes leaf and pod spots of peas. It is extremely difficult to maintain disease-free stocks, particularly in certain years when weather conditions are ideal for the development and spread of diseases. Producing pure seed stocks and using recommended management practices are the safest ways to achieve this end.

Pure seed stocks of varieties are made up from numerous single plant selections. Peas, because of their intertwining habit, are difficult to grow as single lines and it is usually necessary to space-plant them in the field or produce them under greenhouse conditions. The latter method is preferable as disease-free seeds can be produced with the least effort. Each line is evaluated for purity and for trueness to type. The latter includes growth habit, flower color, shape of pods, and seed characters. In this way the plant breeder maintains the purity of the seed stocks used by growers. This, combined with the limited number of varieties used by the trade,

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Lye Solution for Milking Machine Sanitation

C. K. Johns

LATE in 1957, the claim was advanced that lye solution at the usual 0.5 per cent concentration was ineffective in preventing bacterial growth in the rubber parts of a milking machine teat-cup assembly. This was so completely contrary to our own experience—we have used this method since 1930—that we repeated the tests. Again we found that 0.5 per cent lye solution was extremely effective in killing any bacteria present.

In controlled experiments we simulated conditions where the milking machine had been neglected. Units were assembled with the oldest inflations available and soaked with high-count milk to establish a heavy bacterial contamination. After each milking the units were rinsed in tap water, the teat-cup assembly placed on a solution rack and filled with 0.13 per cent lye solution—one-quarter the normal strength. After over two weeks of this, one of these teat-cup assemblies was fitted to a sterilized milker pail and pailhead; the milk from the first cow showed a count of only 6,800 per ml., an astonishingly low value for such treatment.

These results led us to wonder whether the results with our own milker units were really representative of those on ordinary dairy farms. To check on this, we arranged to exchange units with a local milk producer who had been getting high counts from his milk. Three of the four inflations showed considerable deterioration of the rubber surface, and all parts, including the plastic long milk hose, were unquestionably dirty. Between milkings the teat-cup assembly had been stored completely assembled in a crock of cold water, so it was not surprising that high counts were reported on the milk.

We obtained a sample of this producer's milk for the day before we made the exchange; the plate count was 2,600,000 per ml., of which 820,000 survived laboratory pasteurization. At the Central Experimental Farm, the unit was placed in cold water after each milking; counts for the first three days ranged between 900,000 and 1,200,000 per ml. with counts after laboratory pasteurization from 200,000 to 900,000 per ml. At this point a single condition was changed—the teat-cup assemblies were filled between milkings with 0.5 per cent lye solution. The effect was dramatic; by the second day the plate count had fallen to 5,500 per ml., and the count after laboratory pasteurization to 1,000 per ml. After the third day of this treatment, the unit was disassembled, brushed thoroughly, and the rubber parts boiled in 2 per cent lye solution for 15 minutes. This had little effect on the plate count, but brought the count after laboratory pasteurization down to 300 per ml.

While we have had excellent results from the use of lye solution for over 28 years, the findings reported above far exceeded our expectations. It was believed that the counts of heat-resistant organisms would be reduced to a satisfactory level only after the rubberware had been boiled in lye solution; that this was accomplished through the use of wet storage in cold lye solution was both surprising and gratifying.

One drawback to the use of lye solution is that in hard water areas it tends to build up a deposit of mineral salts on the surfaces of equipment. While this deposit may not affect the bacterial count of the milk, it is unsightly and undesirable. In England, the National Institute for Research in Dairying has successfully introduced the use of a chelating agent such as Versene (ethylene diamine tetraacetic acid) in a lye solution to prevent the deposition of calcium and other hard-water salts. This had been tried out at St. Mary's, Ont., through the co-operation of F. J. Riley of the Carnation Company. The results, shown in the accompanying illustration speak for themselves. In consequence, one distributor of sanitation chemicals is preparing to market a product in which the chelating agent is incorporated. This should go a long way toward eliminating these unsightly deposits of hard-water salts.

Dr. Johns is Director of the Dairy Technology Research Institute, Central Experimental Farm, Ottawa, Ont.

Left: Solution rack for maintaining teat-cut assembly filled with lye solution between milkings. **Right:** The effect of a chelating agent in preventing deposition of mineral salts during 6 months use. Liner and plastic milk tube (left) treated with 0.5% lye solution. Similar specimens (right) treated with lye solution plus chelating agent.

Oat Varieties

R. A. Derick

Rodney (top) and Ajax oats.

THE oat variety picture in Canada has changed almost completely over the 20-year period, 1937-58. This has come about chiefly as a result of the efforts of plant breeders to develop varieties that offer some protection against the increasing number of hazards in crop production, particularly diseases.

Scores of varieties have been introduced from Europe, the United States, and other parts of the world during the past half century but few have proved their worth agronomically under Canadian conditions. Even at present, however, such varieties as Granary Filler, Gopher and Abundance are still being grown in a few isolated cases. Probably the greatest contribution that foreign varieties have made towards improvement of the oat crop in Canada has been through germ plasm which plant breeders have used in developing varieties resistant to rust and smut.

Prior to 1938, six varieties had been produced in Canada by hybridization, namely: Legacy, Cartier, Erban, Vanguard, Laurel, and Liberty. The last two are hulless varieties and along with Legacy were developed at the Cereal Crops Division, Ottawa, and released during the 1920's. Cartier, an early maturing variety developed at Macdonald College, Que., was released in 1932, while Erban, developed at the Ontario Agricultural College and Vanguard at the Canada Agricultural Research Laboratory, Winnipeg, were first made available in 1936 and 1937. Erban and Vanguard represent the first effort by Canadian plant breeders to produce oat varieties with resistance to rust. Erban at that time was resistant to two prevailing races of crown rust and Vanguard to several races of stem rust.

In 1938 there were 36 oat varieties eligible for sale in Canada under the Canada Seeds Act. Of these only 13 were actually approved by the provincial variety recommendation committees. Twenty years later there were 65 varieties eligible for sale in Canada, a little more than half of which have either been dropped from commercial use or are grown only in a very limited way. Of the remainder, 23 appear on recommended lists, indicating that they are adapted in one or more areas of the country. All but four of the 23 recommended varieties were developed in Canada by hybridization.

During the ten years 1939-1948, thirteen new varieties were produced in Canada, all resulting from hybridization. Eight of these were originated by the Cereal Crops Division either at Ottawa, or at Winnipeg, namely: Ajax, Brighton (hulless), Exeter, Beaver, Larain, Abegweit, Beacon, and Garry.

New varieties produced by Canadian plant breeders and released during the period 1949-1957 were as follows: Lanark, Torch (hulless), Rodney, Scotian, Shefford, Simcoe, Vicar (hulless), Shield, Glen, and Fundy.

Many of the varieties developed in Canada during the past 20 years are best suited to a particular range of soil and climatic conditions. While it is true that some varieties appear to have wider adaptation than others, many of the so-called widely adapted oat varieties have gradually been replaced in certain zones in favor of newer ones often with narrow adaptability, but with better yield potential, more disease resistance or other improved agronomic characters.

During the last ten years the variety picture has changed almost completely. Even some varieties recommended in 1956 have already begun to lose popularity and are being replaced by newer productions. It is probable that many of the varieties being recommended in 1957 and 1958 will also be replaced in another ten years.

The estimated yields of oats by provinces show a substantial increase in average yield per acre during the ten-year period 1947-1956 over the period 1927-1936 in all provinces except British Columbia. (See Table).

It might be assumed that at least part of the yield increase in the last ten-year period has resulted from the more general use of new varieties. If this assumption is well founded, the plant breeders in Canada have made a substantial contribution towards the national farm revenue. Higher yields may, in part, have resulted from the new varieties being better able to withstand such natural hazards of crop production as diseases and lodging. Better regional adaptability may also have had an influence.

AVERAGE YIELD OF OATS IN BUSHELS PER ACRE BY PROVINCES

—	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.
1927-1936	33.3	34.6	30.2	27.2	33.6	22.0	22.4	31.3	48.8
1937-1946	32.7	33.2	31.6	25.2	36.4	33.2	26.2	23.7	49.1
1947-1956	39.7	40.8	37.7	28.6	40.5	35.8	34.0	37.7	46.8

The author is an Oats Specialist with the Cereal Crops Division, Central Experimental Farm, Ottawa, Ont.

Inverted plants of Kinghorn Wax bean showing effect of seeding rates of 12, 9, 6 and 4 seeds per foot (left to right) on plant height, degree of branching, pod placement, and pod set.

Rates of Seeding Bush Snap Beans for Mechanical Harvesting

J. J. Jasmin[1], *V. W. Nuttall*[2] AND *H. Rondot*[3]

STUDIES on three varieties of bush snap beans have shown that the most economical rate of seeding for mechanical harvesting is 9 seeds per foot, that is, 85 pounds of Slendergreen, 100 pounds of Kinghorn Wax, and 110 pounds of Tendergreen per acre.

In the studies, undertaken in 1957 and 1958 at Ste. Clothilde (marginal muck) and in 1958 at Ormstown (silty clay), the Horticultural Organic Soil Substation co-operated with the Horticulture Division at Ottawa, and the Green Giant of Canada Limited at Ste. Martine, Quebec. In addition to rates of seeding, the influence of plant population in the row on height of plant, height of pods, and number of pods and branches per plant was also studied. The above three varieties, currently grown by the packers, were seeded at rates of 4, 6, 9, and 12 seeds per foot.

Increasing the plant population increased the yields in most cases. When the harvested beans were graded for size, 60 per cent of the pods from the plots with the highest rate of seeding fell into the top-quality commercial grades 1, 2, and 3, as compared with 51 per cent from the lowest rate.

In general the three varieties studied were well adapted to mechanical harvesting. Slendergreen was a slightly better yielder than the other two, probably because the plants were better adapted to the machine as indicated by the small percentage of pods left on the plants after harvest. Kinghorn Wax, with more branches and a shorter plant than Tendergreen, was not so well adapted to the mechanical harvester. The differences between varieties were far less striking than the differences between rates of seeding.

The percentage of pods left on the plants by the harvester was much higher at Ste. Clothilde, than at Ormstown. This was probably because the increased amount of foliage on the beans grown on marginal muck reduced the efficiency of the machine. The average percentage of pods left on the plants at both locations ranged from 11 where the beans were spaced at 4 seeds per foot to 17 where the spacing was 12 seeds per foot.

At 12 seeds per foot, pod placement was nearly three inches higher than at 4 seeds per foot. This is important in terms of mechanical picking efficiency, particularly on rough ground where soil clods and small stones interfere with the removal of pods. Increasing the rate of seeding greatly reduced pod set. Pods per plant ranged from nearly 14 at the lowest rate of seeding to just less than 8 at the highest. However, in terms of yield, the in-

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Bush snap bean harvester mounted on a tractor.

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[2] *Horticulturist, Central Experimental Farm, Ottawa, Ont.*
[3] *Production Fieldman, Green Giant of Canada Limited, Ste. Martine, Quebec.*

Seed Dressing Tests. ***Left:*** **Soybeans in experimental plots; untreated row (foreground), treated (rear).** ***Center:*** **Control of pea aphid on pea seedlings grown from seed treated with a systemic insecticide. Two rows on left are heavily infested while no aphids are present in row on right.** ***Right:*** **Field beans in experimental plots; untreated row (foreground), treated (rear).**

Seed Dressings on Vegetable and Field Crops

L. A. Miller

SEED DRESSING TRIALS were started at the Chatham Laboratory in 1949 and have constituted a year-around testing program since then. Grower acceptance of dressings, while slow in the early stages, has now reached the point in southwestern Ontario where practically all seed of corn, bean varieties, soybeans, sugar beets, and peas is treated with a combination protectant. It was established early in our investigations that seed dressings containing only an insecticide were seldom as effective as those containing insecticide-fungicide combinations. Consequently our recommendations to growers always stress the desirability of using dual-purpose combinations against soil insect pests.

The treating of corn seed at the rate of ½ to 1 ounce of aldrin, dieldrin, lindane, or heptachlor per bushel for the control of wireworms has been so widespread and effective that it is now virtually impossible to locate fields with a high enough wireworm population for control studies. Similarly the seed-corn maggot, the most destructive soil insect pest of beans, soybeans, and peas in Ontario, has been effectively controlled on these crops by the addition of only ¼ ounce of insecticide per bushel of seed—always in combination with a fungicide such as thiram or captan.

The author is a Vegetable Insect Specialist at the Entomology Laboratory, Chatham, Ontario.

All seed of lima beans grown for processing in southwestern Ontario is now treated with a combination insecticide-fungicide seed dressing. Since this practice was universally adopted in 1952, not a single field has had to be reseeded because of seed-corn maggot infestations. Prior to this, it was a rare year in which at least a few fields did not have to be disked under and reseeded. For the same reason all seed of the canning pea crop is treated. Marked increases in germination of all cucurbits tested—cucumber, watermelon, muskmelon, pumpkin, and squash—have resulted when the seed was treated for the control of the seed-corn maggot and diseases. One method of controlling the onion maggot and onion smut simultaneously has been to "pellet" the seed with a high concentration of a combination of aldrin and thiram. In 1958, however, this method failed to control the maggots in some areas of southwestern Ontario and extensive laboratory tests have shown that this pest has developed resistance to aldrin and, to a lesser extent, other compounds of the chlorinated hydrocarbon group.

It seems almost incredible that seed dressings are as effective as they are. When treated at the recommended rates, it has been calculated that one field bean contains approximately 1/500,000 of an ounce of protectant and an onion seed approximately 1/300,000 of an ounce. One might expect a degree of control if these amounts were concentrated at a given point on the respective seeds and if a maggot were to attack the seed at that point. But this incredibly small amount envelops the entire seed coat so the amount at a given point is infinitesimal. Similarly, one of the leading producers of a liquid organic mercury seed dressing, used on cereal crop seeds, showed that the vapors from a mere speck of mercury spread evenly over and literally became anchored to the seed coat. It was further calculated that the weight of this protective film was only one millionth of a gram and that it contained 2,000 billion disease-destroying mercury molecules. These figures stagger the imagination and indicate the potency of the chemicals that are the tools of agriculture today.

A new concept in the protection of plants from insects has now awakened the keen interest of research stations all over the world. By treating the seed of certain crops with what is known as a systemic insecticide, it is possible to impart protection against certain insects attacking aboveground portions of the plant. Systemic compounds are absorbed through the root system and flow in the sap stream to all parts of the plant where they remain for varying periods. Insects are either repelled from feeding or, if they feed, are killed by the insecticide as it is taken up with the plant tissue or sap.

In field trials at Chatham in 1957 and 1958, populations of the Colorado potato beetle, potato leafhopper, and potato flea beetle were controlled for 70 days by treating the potato seed pieces with a

systemic insecticide. The treatments in this case, however, delayed germination and maturity of the crop. Pea aphid populations on canning peas have been held to a non-economic level with systemic seed dressings, but only for a limited time. Much more work is necessary before systemic seed dressings can be recommended for general use. Compounds must be found that are less poisonous to man, less toxic to plants, and that remain effective for longer periods. More research is necessary on existing compounds to determine their effects on many species of insects on a wide range of host plants. But even with these temporary drawbacks, systemic insecticides hold intriguing possibilities, not the least of which is the ultimate control of the plant viruses transmitted by insect vectors.

Seed dressings offer many advantages over other methods of soil insect control.

1. They are relatively inexpensive.

2. Special application equipment is not necessary for individual use.

Author (background) and technician weighing and treating corn seeds.

3. They can be applied during the late winter when more time is available. The seed can be stored until seeding time without harmful effects.

4. They afford protection during periods of adverse weather conditions which delay germination and allow insects and disease a longer time to complete their damage. Seed that is slightly but not visibly damaged during harvest is a poor risk but the risk is much reduced if an effective seed dressing is applied.

5. A more uniform stand is obtained. This is important in the production of the lima bean, wax bean, and canning pea crops that are harvested while still green. It means that the majority of plants from one seeding are ready for harvest at about the same time and losses due to over- or under-maturity are much reduced.

6. There is a saving in the amount of seed necessary to obtain a satisfactory stand.

7. Higher yields of better quality produce can be expected in most years. The response of seeds to treatments varies according to the crop, the vitality of the seed, the abundance of soil pests, the incidence of disease, weather conditions, soil type, and other factors. It is, therefore, impossible to predict how much increase in plant stand and yield can be expected from an effective seed dressing. It is certain, however, that over the years it will pay to treat all vegetable and field crop seeds.

The growing interest in research on seed treatments gives promise of further improvements in this field of insect and disease control in the future.

Field Peas . . . *from p. 6*

Field Peas . . . from p. 6

safeguards the quality of peas which is very important if the pea market is to be maintained and enlarged.

Plant breeders are also responsible for evaluating newly developed varieties and introductions for reaction to disease. Ascochyta diseases and bacterial blight are the most pressing at the moment. Success in breeding disease-resistant varieties, in particular resistance to seed-borne diseases, is likely to be limited until resistant selections are located. Some progress has been made in locating sources of germ plasm that will confer resistance to the four physiologic forms (or races) of *Ascochyta pisi* and a number of single plants have been selected from a variety showing resistance to this disease. We will use these in a breeding program in crosses with other varieties to develop resistant varieties of good quality.

The essential steps necessary to control pea diseases are:

1. Breed resistant varieties as resistant breeding material becomes available.

2. Use antibiotics, fungicides, and insecticides with present varieties in accordance with recommended practices.

3. Practice proper crop rotation, which includes the elimination of pea refuse by burning or plowing under deeply.

The Cereal Crops Division is responsible for conducting co-operative variety trials of peas throughout Canada to evaluate current material as well as varieties developed in foreign countries. One hybrid has proved to be outstanding in our tests with respect to yield and maturity range. Additional testing is required to obtain the final evaluation of this hybrid with respect to such characters as suitability for combine harvesting, seed appearance, and acceptability by the trade.

Field peas are a relatively specialized crop and require careful management to produce a top quality product. However, they can be grown in conjunction with cereals and thus provide another crop for farm diversification.

Rates of Seeding Snap Beans . . . *from page 9*

creased plant population more than offset the low pod set.

There were approximately two less branches on plants at the highest rate of seeding. This would tend to shape the plants for more efficient harvesting. In terms of bulk of foliage, this decrease may have been offset by the increased population of plants.

Based on the results of this study we can conclude that rates of seeding beans for mechanical picking should be increased, not only to shape the plants for more efficient harvesting but also to increase yields, since only one picking is made compared with three or more pickings with hand labor.

Microbial Insecticides

T. A. Angus AND *A. E. Heimpel*

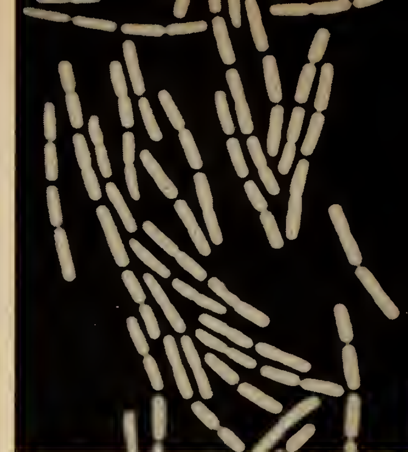
THE search for new ways to kill insects has focussed attention on the microbial insecticides which take advantage of the fact that insects, like other living forms, are killed by microorganisms. Virus diseases of insects have been used with some success in control work but viruses can develop only in the living insect, making it difficult to produce large quantities on demand. On the other hand, some of the bacteria that attack insects can be grown outside the insect host, so that large quantities of bacteria can be produced at low cost.

Some of the most promising bacterial pathogenes are related to *Bacillus thuringiensis,* originally isolated from diseased flour-moth larvae. Similar strains have been found in silkworm. Although it has been known for many years that a number of lepidopterous species are killed by bacteria of this type, the cause of death was not understood. As a result of studies at the Insect Pathology Research Institute in Sault Ste. Marie, Ont., and the Pesticides Research Institute at London, Ont., much more is now known of the mode of action of these spore-forming aerobes.

Three companies in the United States have lately begun producing *Bacillus thuringiensis* in quantity for use as a microbial insecticide. Extensive field trials were carried out in 1958 and will be continued in 1959.

When spores of *Bacillus thuringiensis* are introduced into a suitable nutrient solution they germinate and give rise to enormous numbers of vegetative rods. Eventually in each of these rods a spore, and another body called a crystalloid parasporal inclusion, develops. This crystal is composed of a substance that is toxic for the larvae of many insects. The toxic substance is a protein that when swallowed by an insect, causes a paralysis. With some insects paralysis is complete, with others only the gut is paralyzed; but the practical effect is that shortly after eating a small amount of foliage coated with the toxin the insect ceases feeding. In most species affected the toxin alone is sufficient to cause death, in others the presence of both the toxin and growing bacteria is required.

Insect species known to be affected by *Bacillus thuringiensis* include many economic pests such as bollworms, hornworms, tent caterpillars, insects attacking cabbage and related plants, and many important forest and orchard pests. Useful insects such as the hymenopterous and dipterous parasites, and the pollinators, do not seem to be affected. In field tests conventional spraying and dusting equipment and methods have been used with success. As experience is gained it is probable that new techniques will have to be developed. For example, the spreaders used with conventional insecticides may be unnecessary or even undesirable with insecticides that are essentially stomach poisons and do not rely on contact action. A new type of water-insoluble sticker (non-toxic for plants and animals) is available which is compatible with *Bacillus thuringiensis* and makes possible a protective application that is highly resistant to weathering.



Top left: **Vegetative rods of *Bacillus thuringiensis* multiply on suitable media; cultures, at this stage, are not toxic for insects. *Top right:* Later, spores and crystals are formed in the vegetative cells; crystals are composed of a protein that is extremely poisonous for many Lepidoptera. *Lower:* The crystals, separated from spores and cell debris, as they appear in the electron microscope; crystals alone are just as toxic for insects as the crude culture.**

An attractive feature of the microbial insecticides so far tested is that they appear to be harmless for plants, humans, and farm animals. One of the American manufacturers advises against inhaling their product. There is no proved

Ephestia kuehniella **larvae (left) are the natural host of the disease organism *Bacillus thuringiensis*. Larvae (right) of this insect die 36 to 48 hours after feeding on flour containing spores and crystals of this bacterium.**

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hazard, but they advise this precautionary measure. All the experience to date is that the materials are safe to use. Little is known with respect to the ability of susceptible strains of insects to develop resistance to microbial insecticides, but their comparative cheapness and non-toxicity for plants and animals would seem to indicate that overdosage could be deliberate, thus decreasing the chances of a resistant strain developing.

The microbial insecticides are produced by the submerged broth fermentation process. Large tanks of a suitable nutrient source are inoculated with a laboratory-grown starter culture and aerated with sterilized air. After a suitable incubation period the tank will contain astronomical numbers of spores and crystals, and the remains of the vegetative rods that produced them. When the growth is complete the spores and crystals are harvested in centrifuges or by spray-drying. The dry product is a tan-colored powder that is not unlike dried brewers yeast in appearance. The dried powder is ground to a uniform particle size so that it will not clog the screens or nozzles of applicators, and is extended with suitable fillers. It is quite stable when stored under dry conditions, and retains its biological activity for many years.

As has been explained, the dried cultures contain both spores and crystals, and with most of the insect species tested the toxic material from the crystal, and not the spore, is the essential agent. There would seem to be little point in further purifying the dried spores and crystals for field use. As it comes from the fermentors, the toxic material is present in an inert, extremely stable condition but it is immediately activated when taken into the insect gut. The spores too are very stable, and although in most cases their role seems to be secondary, with some insects they undoubtedly add to mortality.

Even though *Bacillus thuringiensis* as an insecticide has reached the pilot-plant stage of development there are some very promising leads still to be pursued. Other bacteria closely related to *Bacillus thuringiensis* exhibit a slightly different activity spectrum. Some of them are more toxic but for various reasons less suitable for field use. Continued screening and selection will undoubtedly uncover more effective strains.

Most lepidopterous larvae shortly after feeding on foliage sprayed with crystal-forming bacteria are unable to continue feeding. On the left, *Datana ministra* larvae placed on clean birch foliage consumed it entirely in 24 hours. Foliage (right) coated with a crystal-forming bacteria was protected. The inability of the insects to continue feeding is due to the paralytic action of the toxin on the insect gut.

The toxic product of the crystal-bearing, spore-forming bacteria has been partially purified and studied. It appears to be almost unique in some of its properties for there are few if any other proteinaceous compounds with marked insecticidal action. In a series of tests the lethal dose of extracted toxin was found to be less than a millionth of the body weight of a larva. The natural toxin as it occurs in the crystal is thought to be even more toxic. Thus the toxin is slightly more toxic for susceptible lepidopterous larvae, on a weight basis, than DDT.

Biochemists are intrigued by the thought that there may be a family of insecticidal proteinaceous compounds whose toxicity can be enhanced by suitable treatment. It is not beyond the bounds of possibility that when the structure of the toxin is finally elucidated other compounds similar in structure and insecticidal powers may be synthesized directly rather than depending on a biological process for their production.

Sprinkler Irrigation of Flue-Cured Tobacco . . *from p. 4*

operating such systems, but any rate in this range is satisfactory for coarse-textured tobacco soils and rates in the lower one-half of the range for finer-textured soils.

We need a reliable method of determining the *time of application*. The plant is a good indicator of a soil moisture deficiency, but results show that irrigation should commence before plant symptoms become pronounced. Irrigation water may be applied to correct rainfall deficiencies, but this method provides only a rough guide and may result in the use of too much or too little water depending upon weather conditions. Thornthwaite evapotranspiration estimates are a satisfactory basis for scheduling irrigation requirements, although certain adjustments in the soil moisture account must be made for best results. Soil moisture blocks have also proved to be satisfactory indicators provided some adjustments are made in the usual techniques. Scheduling of irrigation according to time intervals or stages of growth has been unsatisfactory, although irrigation has been of more benefit in the "knee-high to bloom" period, extending through the last three weeks of July, than at any other time during the season.

It has been generally believed that irrigation would necessitate additional fertilizer applications. It is true that a properly irrigated crop utilizes more fertilizer than an unirrigated crop, particularly in a dry year, but the fertilizer recommendations for unirrigated tobacco have been satisfactory for irrigated tobacco because they have been based on ideal or near ideal growing conditions.

A gauche, orme sain. A droite, orme moyennement atteint de la maladie hollandaise.

A la recherche d'un orme d'Amérique résistant à la maladie hollandaise de l'orme

C. E. Ouellet

De découverte relativement récente, la maladie hollandaise de l'orme s'est répandue en Europe et en Amérique avec une rapidité étonnante. Au Canada, le Dr Pomerleau la dépista pour la première fois à Saint-Ours, près de Sorel, Québec, en 1944. Cette maladie est causée par un champignon microscopique qui se développe dans les vaisseaux de l'aubier. Le lecteur désireux d'avoir une description détaillée de cette maladie et de connaître les moyens de lutte préconisés actuellement peut se procurer la publication nº 1010 du Ministère de l'Agriculture du Canada intitulée "La maladie hollandaise de l'orme".

Vu les dommages importants causés par cette maladie dans la province de Québec, la Ferme expérimentale de L'Assomption commença à travailler sur ce problème en 1951, afin de trouver par sélection une lignée d'orme résistante. Au cours des premières années de recherches, on s'efforça surtout de trouver des méthodes pratiques de multiplication tant par voie de semis que de boutures. L'établissement de ces méthodes, qu'il serait trop long de décrire dans cet article, s'imposait pour conduire efficacement le travail projeté. Depuis, la sélection proprement dite est conduite de façon intensive.

L'objet principal de ces recherches est la découverte d'une lignée d'orme d'Amérique ayant acquis de la résistance à la maladie hollandaise à la suite d'une mutation survenue naturellement ou provoquée artificiellement.

L'auteur est spécialiste en horticulture, spécialement chargé de recherches sur la maladie hollandaise de l'orme, à la Ferme expérimentale, L'Assomption, Que.

Résistance de l'orme à la maladie hollandaise dans la nature

Certains chercheurs soutiennent qu'il n'existe pas de vraie résistance à la maladie hollandaise de l'orme dans la nature, mais seulement de la tolérance à cette maladie. Ainsi en serait-il des ormes chinois et de certaines variétés européennes, comme les ormes de Christine Buisman et de Bea Schwarz.

Quant à l'orme d'Amérique, il s'avère très susceptible à la maladie. A la Ferme expérimentale de L'Assomption, de nombreux arbres adultes, situés en des colonies infectées, ont été éprouvés pour leur résistance à la maladie hollandaise. Cette épreuve s'est faite au moyen de boutures prélevées sur ces arbres, enracinées en serre, et inoculées quelques années plus tard avec une suspension de spores de l'organisme pathogène. C'est le Laboratoire fédéral de pathologie forestière de Québec qui a préparé les cultures du champignon et a procédé à l'inoculation. Malheureusement, aucun de ces arbres ne s'est avéré résistant.

On a éprouvé également des milliers d'arbustes, environ 25,000, provenant de semis. Même si 16 p. 100 d'entre eux résistèrent à une première inoculation, aucun arbuste au développement normal ne survécut à plus de trois années d'inoculation. En somme, ces épreuves n'ont permis de déceler aucune résistance importante à la maladie hollandaise chez l'orme d'Amérique.

Selon quelques auteurs, certaines espèces et lignées d'orme sont tolérantes parce que le champignon de la maladie, même s'il est présent, n'y développe pas les toxines qu'il forme dans les espèces susceptibles, toxines qui causent la flétrissure du feuillage et finalement la mort de l'arbre. Plusieurs observations portent à croire qu'une abondante circulation de la sève inciterait le champignon à développer ces toxines. Des expériences effectuées en serre durant trois ans à la Ferme expérimentale de L'Assomption ont démontré que la réaction à l'inoculation chez des ormes d'Améri-

A gauche: Symptômes de la maladie sur des ormes d'un an ayant subi l'épreuve de l'inoculation en serre. I (à gauche)—ormes sains; II (à droite)—ormes malades. *A droite:* Enracinement en serre de boutures d'orme d'Amérique, prélevées sur des arbres adultes devant être éprouvés pour leur résistance possible à la maladie hollandaise.

que d'un an est toujours plus forte chez les sujets les plus longs et les plus vigoureux que chez les autres. Les toxines produites, qui ont une grande puissance d'hydratation, ralentiraient la circulation de la sève et, à mon humble avis, permettraient au champignon de se développer en des conditions d'humidité qui lui conviennent. Ce serait le cas pour les espèces d'ormes à grand développement, surtout lorsque la vigueur est bonne et la croissance très active. La tolérance à la maladie hollandaise semble donc liée à une faible puissance de développement. Se basant sur cette conception des causes de la maladie hollandaise, on peut encore espérer trouver dans la nature des lignées d'orme d'Amérique tolérantes, mais à développement relativement faible. On peut se demander si le croisement de l'orme d'Amérique avec des lignées d'orme européennes ou asiatiques tolérantes ne donnerait pas les mêmes résultats. Cependant, les causes des dommages produits par l'organisme pathogène dans l'orme étant peu connues, de tels croisements seraient certainement très utiles et pourraient donner des résultats insoupçonnés.

Quant à trouver de la véritable résistance au champignon lui-même dans la nature, tout porte à croire que la possibilité en est très mince. Car ce ne pourrait être le fait que d'une très rare mutation, vu que l'orme d'Amérique est de constitution génétique tétraploïde et que la tétraploïdie confère beaucoup de stabilité à une espèce et rend les changements de nature héréditaire très difficiles.

La production de mutations, source possible de résistance chez l'orme d'Amérique

La possibilité de trouver dans la nature une véritable résistance au champignon de la maladie étant très mince, on essaie depuis quelques années de la produire en provoquant des mutations artificiellement. Dans ce but, un petit nombre de graines d'ormes a été jusqu'ici traité par des produits chimiques et des agents physiques, tandis qu'une assez forte quantité a été exposée aux radiations. On ne pourra juger de l'effet de ces traitements sur la résistance à la maladie hollandaise avant quelques années. Soumis à l'épreuve de l'inoculation, les jeunes plants d'orme peuvent échapper à l'infection deux ou trois ans avant de contracter la maladie.

Les produits chimiques utilisés ont été la colchicine, le dichlorobenzine, l'acide formique et les 2,4-D amine et ester. La chaleur et le froid sont les agents physiques qui ont été essayés. On ne constata pas de modifications morphologiques notables sur les plants obtenus de graines ainsi traitées.

L'orme d'Amérique étant déjà de constitution génétique tétraploïde, l'usage des radiations qui agissent plus spécialement sur les

Plantation d'ormes d'un an prêts à subir l'épreuve de l'inoculation.

gènes des chromosomes semble plus prometteur que celui des produits chimiques et physiques, dont le rôle est surtout de produire de la tétraploïdie. C'est pourquoi il nous a semblé préférable jusqu'ici d'utiliser surtout les radiations comme agent mutagénique.

Depuis quelques années déjà, deux institutions ont l'obligeance d'irradier des graines d'orme d'Amérique pour nous, soit la Ferme expérimentale de Kentville qui en a traité aux rayons X et le Laboratoire de Brookhaven aux États-Unis qui en a traité d'autres aux neutrons thermiques. On a déjà obtenu 45,000 plants de graines ainsi irradiées, plants qui ont déjà reçu une ou deux inoculations. S'il est encore trop tôt pour juger de l'influence des radiations sur la résistance à la maladie hollandaise, ce travail a tout de même permis certaines observations intéressantes relativement à la germination des graines irradiées et à la croissance des plants qui en sont résultés. L'irradiation aux rayons X à une dose de 6000 r (r=Roentgen), et l'exposition aux neutrons thermiques à des doses de 6.98×10^{8} et 1.62×10^{13} neutrons appliqués respectivement durant des périodes de 4 à 6 heures, permettent l'obtention d'un nombre raisonnable de plants. Après l'émergence, la mortalité des plantules, qui peut être très élevée dans le cas des neutrons thermiques appliqués à des doses relativement fortes, est faible dans le cas des rayons X. A l'automne suivant le semis, les plants venant de graines traitées aux neutrons thermiques présentent beaucoup plus de variation dans la hauteur que ceux venant de graines traitées aux rayons X. Le nombre de plants viables obtenus de graines traitées aux neutrons thermiques semble être plus influencé par la longueur de la période d'irradiation que par l'intensité du taux d'irradiation lui-même.

Tous ces traitements présentent une difficulté commune. Ils peuvent modifier dans une graine telle ou telle cellule ou groupe de cellules à l'exclusion des autres et seules les branches provenant de ces cellules sont le siège de mutation, ce qu'on désigne en génétique sous le nom de chimère. Pour obvier à ceci, on prélève des boutures sur les branches ne présentant pas de symptômes de maladie après l'inoculation, boutures qui sont enracinées en serre et inoculées quelques années plus tard pour connaître leur résistance à la maladie.

Comme conclusion, il faut bien admettre que les recherches effectuées jusqu'ici en vue de trouver une lignée d'orme d'Amérique résistante à la maladie hollandaise n'ont pas encore permis d'obtenir la résistance désirée. Tout de même, elles ont donné beaucoup de renseignements sur la multiplication de l'orme par voie de semis et de boutures, sur les méthodes de sélection et d'inoculation de l'orme et sur les effets des radiations. Et, comme il est toujours permis d'espérer de la résistance à la maladie hollandaise en provoquant des mutations par des agents mutagéniques, en particulier les radiations, il semble sage de continuer ces recherches.

Safflower blossoms and seed (inset).

Has Safflower Been a Success

in Canada?

W. G. McGregor

THE farmers in Alberta who diverted 15,000 dry-land acres from wheat to safflower in 1957 found a ready market for their crop. They were pioneering a new industry in Western Canada though the crop had been introduced during the drought of the thirties in the hope that it might find a place in the dry areas. Tests conducted by the Department had shown that it was best suited to southern Alberta.

The safflower plant is a bushy annual thistle. It grows to a height of 20 to 36 inches and branches freely, depending upon the moisture condition and the spacing of the plant. All branches terminate in one or more flowering heads 1 to 2 inches in diameter. The seeds which somewhat resemble white sunflower seeds are as large or larger than barley kernels and weigh from 35-40 pounds per bushel.

Safflower has appealed to farmers who wish to divert acreage from wheat and other cereals since it fits into local crop rotations in the same way as any full season spring planted crop. It is easily handled with ordinary mechanical equipment and seedbed preparation and seeding are similar to those in use for spring grains. Many crops in Alberta in 1958 were harvested by straight combining. This can be done after the harvesting of all other crops as safflower is very resistant to shattering and lodging. A good crop of safflower seed contains about a third oil plus a feed supplement rich in protein. Safflower oil is prized by the paint industry because of its colorless properties and because it will not yellow with age.

Safflower has been tested at the Experimental Farm, Lethbridge, for several years in comparison with flax. The variety Indian produced an average of over 1,700 pounds of seed per acre in experimental plots on dry-land throughout the period 1952-57. Flax yields averaged a little better than 800 pounds. Results from the first commercial crop in 1957 varied widely from 200 to 1,200 pounds per acre. However, encouraged by the ready market for this crop, the acreage increased in 1958 to 18,000 acres in Alberta and 27,000 acres in southwestern Saskatchewan. The contract price of $2\frac{1}{2}$ cents a pound paid farmers in 1957 was raised to $2\frac{3}{4}$ cents for the 1958 crop. Farmers growing an average crop of 20 bushels of wheat per acre at $1.30 per bushel would receive $26.00 per acre. At $2\frac{3}{4}$ cents per pound for safflower, they would have to produce 950 pounds per acre to equal this.

With the introduction of a new crop some adjustments in agronomic practices will always be required before its potential value is established. Growers can improve on these with experience. Some of the poor yields in the 1957 crop were the result of late seeding as safflower requires the whole season to mature. In addition, in a number of fields the stands were too thin resulting in severe competition with weeds. Growth at first is slow and clean stands may be difficult to obtain. The average yield per acre in 1958 was about 560 pounds as compared with 450 pounds the previous year. It is obvious that considerable improvement must still be made in the culture of the crop. Seed of good germination should be planted at about 30 pounds per acre on clean summerfallow.

Safflower has considerable drought resistance yet it benefits greatly from soil moisture for germination and growth. Low relative humidity during the latter part of the flowering season is essential for good seed set and high oil content. Fall irrigation, where possible, would supply moisture early in the season when it is most needed and give increased yields.

The crops in 1957 and 1958 were grown under contract and most of the seed was marketed in Japan. While it is still advisable to make prior arrangements for marketing, the opening of an oilseed processing plant at Lethbridge will provide a local market.

In addition to the work at the Experimental Farm, Ottawa, a new breeding and improvement program is in progress at Lethbridge designed to provide more desirable varieties for both dry-land and irrigated production. Safflower will continue on the road to success with the increase in our knowledge on cultural practices and with the advent of higher yielding varieties.

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